Latent classes of smartphone dependency trajectories and predictors of classes among middle school students in South Korea

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ABSTRACT

Purpose: With widespread use of smartphones, side effects of smartphone dependency among adolescents are emerging as a social problem. Screening high-risk groups is important for appropriate interventions to prevent smartphone dependency in early adolescence. This study thus aimed to identify latent classes of smartphone dependency trajectories and predictors of classes among South Korea's middle school students.

Design and methods: We used data from 2164 middle school students from the Korean Children and Youth Panel Survey (2018–2020). Latent growth curve modeling (LGCM) was performed to confirm the longitudinal trajectory, and latent class growth modeling (LCGM) was performed to identify latent classes of middle school students' smartphone dependency. Then, multinomial logistic regression analysis was conducted to explore predictors of the classes.

Results: The LGCM showed that the trajectory of all middle school students' smartphone dependency increased (intercept 30.65, slope = 1.09). However, the LCGM identified three latent classes: (1) low-stable (intercept 23.01, nonsignificant slope), (2) medium-increasing (intercept 30.37, significant increasing slope), and (3) high-increasing (intercept 37.79, significant increasing slope). Predictors of each latent class included gender, aggressive behavior, self-esteem, parental smartphone dependency, parenting attitude, and negative peer relationships.

Conclusion: The results indicate that the smartphone dependency trajectory of all adolescents is not the same, and there are latent classes with different trajectory patterns.

Practical implications: These findings may contribute to the development of nursing interventions for the smartphone dependency of adolescents. Such interventions should encourage positive factors and eliminate negative factors and, especially, involve parents.

Introduction

Significant advances in the information technology industry have increased the use of smartphones worldwide. In particular, South Korea (hereafter Korea) has the highest smartphone penetration rate in the world (Bae, 2022), and many adolescents are using smartphones. However, adolescents' use of smartphones has its pros and cons (Fischer-Grote et al., 2019). For adolescents who easily access and use digital devices in their daily lives since childhood, smartphones are a part of life and a tool to communicate with society. However, excessive smartphone use raises concerns about smartphone dependency (Kwon, 2021; Lin et al., 2022).

Recently, COVID-19 made adolescents' smartphone dependency even more serious as they spent more time learning and living at home (National Information Society Agency, 2022). According to the 2021 Survey on Smartphone Overdependence in Korea, children and adolescents aged 10–19 years are at the highest risk (37%) of smartphone dependency compared with all other age groups; this indicates an increase of 6.8% compared to 2019. Such an increase in the risk of addiction is severe among all age groups. According to school age, the risk of addiction among middle school students is 41%, which is the highest compared with that of elementary school students (33.9%) and high school students (36.4%; National Information Society Agency, 2022).

The middle school years correspond to early adolescence, which is the transition from childhood to adulthood. The age range in Korea based on school level is 7–12 years for elementary school, 13–15 years for middle school, and 16–18 years for high school. During this time, many adolescents experience drastic physical, mental, and environmental changes (Whaley & Wong, 1997). They are more likely to be exposed to the dysfunction that smartphones bring because of their increased curiosity and greater inclination to seek stimuli along with a desire for new experiences (Duan et al., 2021). When a smartphone is used functionally, it has a positive effect such as in acquiring information necessary for study, building peer relationships, and relieving stress (Fischer-Grote et al., 2019). However, because the frontal lobe, which controls impulsivity and patience, is still developing during adolescence, some adolescents have difficulties controlling their behavior, which can result in smartphone dependency problems (Jin et al., 2016; Lin et al., 2022).

Media dependency, such as smartphone dependency, is formed under the interdependent influence of the individual, the media, and various environmental systems (Ha & Lee, 2020; Kwon, 2021). According to Bronfenbrenner's ecological framework for human development, systems are composed of both individual and environmental systems. Individual systems are classified as physical, psychological, and behavioral elements that influence human behavior or personality. Environmental systems refer to social systems such as family, friends, peer groups, and communities (Bronfenbrenner, 1994; Kwon, 2021).

Previous studies showed that the factors influencing smartphone dependency are broadly categorized as follows: individual, parent's, relationship, and demographic factors from an ecological perspective (Park et al., 2017). Previous studies indicated that individual factors affecting smartphone dependency included aggression (Kim & Lee, 2018), depression (Yue et al., 2021), low self-esteem (Choi, 2020; You et al., 2019), and social withdrawal (Choi, 2020; Kwon, 2021). The family factor has been observed as a major environment that influences smartphone dependency. Prior studies showed that parents' inappropriate parenting attitudes (Lee, 2017; Lee & Kwon, 2021) and low self-esteem (Choi & Kim, 2020) were associated with children's smartphone dependency. Moreover, parents' own smartphone dependency can affect that of their adolescent children (Cho & Cho, 2021). In addition, school factors are cited as a social environment related to adolescents' smartphone dependency. In particular, middle school students' smartphone dependency is affected by their relationships with peers who support them emotionally (Lee & Lee, 2019) and teachers as adults who interact with and influence them closely after parents (Park & Ko, 2020). If students do not feel satisfied in their school life, they may spend more time immersed in smartphones (Hwang & Lee, 2018). Additionally, girls are found to be more dependent on smartphones because they tend to communicate more using smartphones than boys (Cho, 2019; Lee & Kim, 2020; Son et al., 2021). Moreover, parents' low education or economic level is associated with smartphone dependency (Lee & Kim, 2020).

However, most preceding research on smartphone dependency in adolescents comprises cross-sectional studies, and longitudinal studies reflecting changes over time are lacking. Recently, longitudinal research was attempted by some studies (Cho, 2019; Kim et al., 2021; Yoon et al., 2020). However, they were limited as they explored entire population and did not consider subgroups with different trajectories of change. A person-centered analysis can help address this issue. A person-centered analysis such as latent class growth modeling (LCGM) identifies latent classes with different trajectories according to individual response patterns. LCGM is effective in showing different trajectories of change within a population by identifying subgroup types in people based on empirical data (Bollen & Curran, 2006).

This study is based on the results of previous studies and considers that there are heterogeneous subgroups with different trajectories of smartphone dependency among adolescents (Elhai et al., 2020; Ha, 2014; Lee & Yeum, 2018; Seo & Choi, 2018; Yue et al., 2021). Previous studies divided the subgroups of adolescents with different smartphone dependency into two to three classes. However, these studies conducted in China (Yue et al., 2021) or the United States (Elhai et al., 2020) and the study in South Korea used panel data of middle school students in the 2010s (Ha, 2014; Lee & Yeum, 2018; Seo & Choi, 2018). Owing to the nature of person-centered analysis, which can change the latent classes according to the characteristics of the panels included in the study (Laursen & Hoff, 2006), it is necessary to perform repeated studies using the latest panel to confirm the current smartphone-dependent latent class of middle school students in Korea. Therefore, this study aimed to identify longitudinal changes in smartphone dependency among subgroups using recent panel data targeting Korean middle school students—the age group with the highest smartphone dependency.

In addition, we aimed to identify predictors that classify latent classes; the goal is to provide evidence to prevent middle school students' smartphone dependency and intervene in this high-risk group. As media dependency develops under the interdependent influence of environments at different levels, it is necessary to consider various factors related to the home and school system surrounding the individual (Ha & Lee, 2020; Kwon, 2021). Most previous studies only explored the relationship between specific factors and smartphone dependency (Cho & Cho, 2021; Choi & Kim, 2020; Hwang & Lee, 2018; Kim & Lee, 2018; Lee, 2017; Lee & Lee, 2019; You et al., 2019; Yue et al., 2021); therefore, this study generally included demographic, individual, parents, and relationship factors. Such an ecological approach will provide clues to develop interventions for adolescents.

Methods

Design and sample

This study conducted secondary data analysis using data from the Korean Children and Youth Panel Survey 2018 (National Youth Policy Institute, 2019). The survey population of the KCYPS 2018 was students in the fourth grade of elementary school and first grade of middle school as of 2018; moreover, the 2017 basic education statistics of the Ministry of Education were used as the sampling frame. Sampling was established using multistage stratified cluster sampling. After obtaining information on the number of classes in the corresponding grade, number of students in each class, and number of students by gender, one class per school was randomly selected for the survey. All students in the selected class were included in the survey. If the survey was rejected during the contact process with the sample school, it was replaced with another school with the most similar characteristics. The school consented to contact the cohort survey, and the consent rate for the cohort survey was 66.1% (2590 people/3916 people). Two interviewers visited the home of the child/adolescent who agreed to participate in the survey with a tablet personal computer and conducted the survey targeting the participating children/adolescents/guardians.

The KCYPS 2018 panel sample included adolescents in the first year of middle school ($N = 2590$); since the first survey in 2018, follow-up surveys are conducted every year. We built a data set that integrated data for each year from 2018 to 2020 based on personal identifications; we then selected middle school students who participated in all 3 years ($N = 2242$). In addition, characteristics of the fathers or mothers who were primary caregivers were included as independent variables in this study. Therefore, if the caregiver questionnaire was completed by someone other than the primary caregiver parent (e.g., the mother is the primary caregiver, but the survey respondent is the father, grandparent, or relative), the participants were excluded from the study ($n = 78$). Finally, 2164 middle school student responses were used for analysis.

Measures

Outcome Variable: Smartphone dependency

In the KCYPS 2018, middle school students' smartphone dependency was measured by modifying the Smartphone Addiction Proneness Scale for Adults (K-SAS) developed by Kim et al. (2012). The K-SAS consists of 15 questions answered on a four-point Likert scale (1 = not at all; 4 = very much). After reverse coding three items, the total score was used for analysis. This total score ranged from 15 to 60; the higher the score, the higher the smartphone dependency. In the study by Kim et al. (2012), the Cronbach's alpha was 0.81; in this study, it was 0.88, 0.87, and 0.88 in 2018, 2019, and 2020, respectively.

Demographic factors

Information about gender, parent's education level, and subjective household economic status was used for data analysis. Parent's education level and subjective household economic status were included in the caregiver questionnaire. Further, the parent's education level was classified as high school or lower and college or higher. The subjective economic level was categorized as good (very good and good), fair, and poor (poor and very poor) based on five original categories (very poor to very good). This method refers to how previous studies using KCYPS manipulate the subjective economic level (Chu et al., 2020; Kim & Min, 2019; Lee, 2019).

Individual factors

Aggressive behavior, self-esteem, social withdrawal, and depressive symptoms reported by middle school students were used for data analysis. Aggressive behavior was investigated in the KCYPS 2018 through six items of aggressive behavioral factors on the Emotional and Behavioral Problem Scale developed by Cho and Lim (2003). Each item was evaluated using a four-point Likert scale (1 = not at all; 4 = very strongly), and the total score ranged from 6 to 24. A higher total score indicated higher level of aggressive behavior. Regarding reliability, the Cronbach's alpha at the time of development was 0.76 (Cho & Lim, 2003); in this study, the Cronbach's alpha was 0.84.

Middle school students' self-esteem was measured using Rosenberg (1965) Self-Esteem Scale in the KCYPS 2018. The scale consisted of 10 items and was evaluated using a four-point Likert scale (1 = very true for me; 4 = not at all true for me). Five negative items were reverse-coded, and a higher total score indicated higher self-esteem. Cronbach's alpha of the original scale was 0.85 (Rosenberg, 1965) and in this study was 0.87.

Social withdrawal was evaluated by modifying the Behavior Problem Scale for Children and Adolescents (Kim & Kim, 1998). The scale consists of five items rated using a four-point Likert scale (1 = strongly disagree; 4 = strongly agree), with a higher total score indicating increased levels of social withdrawal. Cronbach's alpha of the original scale was 0.79 (Kim & Kim, 1998) and in this study was 0.87.

Depressive symptoms were evaluated using 10 items of the Symptom Checklist-90-Revised (Kim et al., 1984). Each item was rated using a four-point Likert scale (1 = not at all; 4 = very strongly). A higher total score indicated higher level of depressive symptoms. In the previous study, Cronbach's alpha was 0.89 (Lee, 1994) and in this study was 0.92.

Parent's factors

The parent's smartphone dependency, parenting attitude, and self-esteem were used for data analysis. The parent's smartphone dependency and self-esteem were included in the caregiver questionnaire, and their parenting attitude was included in the child/adolescent questionnaire.

The parent's smartphone dependency was measured using the K-SAS (Kim et al., 2012). This scale consists of 15 items measured using a four-point Likert scale (1 = not at all; 4 = very much). The higher the total score, the higher the smartphone dependency. Cronbach's alpha was 0.81 in Kim et al. (1984) and 0.87 in this study.

Parenting attitude was measured using the Korean version of the Parents as Social Context Questionnaire for Adolescents (Kim & Lee, 2017). Here, parenting attitude consisted of 12 positive and 12 negative parenting attitude items. Each item was evaluated on a four-point Likert scale (1 = not at all; 4 = strongly agree). Items corresponding to negative parenting attitudes were reverse-coded. The higher the total score, the more positive parenting attitudes were interpreted. Reliability of the scale was 0.93 for positive parenting attitudes and 0.88 for negative parenting attitudes in previous studies (Bae & Sung, 2020); it was 0.92 in this study.

The parent's self-esteem was measured using Rosenberg (1965) Self-Esteem Scale. The scale consists of 10 items evaluated using a four-point Likert scale (1 = not at all; 4 = strongly agree). Five negative items were reverse-coded; therefore, a total higher score indicated higher self-esteem. Cronbach's alpha of the original scale was 0.85 and 0.84 in Rosenberg (1965) and this study, respectively.

Relationship factors

The KCYPS 2018 utilized the Peer Relationship Quality Scale for Adolescents developed by Bae et al. (2015) to measure peer relationships. The scale consists of 13 items, 8 for the positive peer relationship factor and 5 for the negative peer relationships factor. Each item was rated on a four-point Likert scale (1 = not at all; 4 = very much). The higher the positive factor score, the more positive the peer relationship, and the higher the negative factor score, the more negative the peer relationship. In previous studies, reliability of the scale was 0.88 for positive peer relationships and 0.71 for negative peer relationships (Lim, 2020); its reliability in this study was 0.90 for positive peer relationships and 0.73 for negative peer relationships.

In the KCYPS 2018, the relationship with teachers was measured using the Student-Teacher Attachment Relationship Scale developed by Kim and Kim (2009). The scale comprised 14 items, and all items were measured on a four-point Likert scale (1 = not at all; 4 = very much). The total score was calculated, and a higher score indicated a better quality of the student-teacher relationship. The Cronbach' alpha was 0.88 and 0.91 in Kim and Kim (2009) and this study, respectively.

School satisfaction in the KCYPS 2018 was measured by modifying and supplementing the following KCYPS 2010 question: "How satisfied are you with your school life?" The response to this question was evaluated on a five-point scale ranging from 1 for very dissatisfied to 5 for very satisfied.

Data analyses

The trajectory of smartphone tendency among all middle school students was explored using unconditional latent growth curve modeling (LGCM). Model fit was evaluated based on the comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). Excellent fit to the data was indicated by CFI and TLI values of ≥ 0.95 and RMSEA values of ≤ 0.06 (Hooper et al., 2008). LCGM was conducted to distinguish groups of middle school students characterized by distinct trajectories of smartphone dependency. The LCGM analysis identifies subgroups based on empirical data, showing different trajectories within a group (Nagin, 1999). To determine the number of latent classes, the Akaike information criterion (AIC), Bayesian information criterion (BIC), and adjusted BIC were reviewed. In the final analytical step, a multinomial logistic regression analysis was performed to confirm the predictors of each latent class.

For descriptive statistics, a χ^2-test, one-way analysis of variance, and multinomial logistic regression analysis were conducted using SPSS/WIN 26.0 (IBM Corp., Armonk, NY, USA). The LGCM and LCGM were

analyzed using Mplus 7.0 (Muthén & Muthén, Los Angeles, CA, USA).

Ethical considerations

This study was conducted using publicly available data, and it was exempted from deliberation by the Institutional Review Board of the University of Ulsan (IRB No. 1040968-E-2022-001). The KCYPS is an Official National Statistics (No. 402002), and the individuals' and school-related information was strictly confidential in accordance with Article 33 of the Statistics Act (Protection of Secrets) and Article 3 of the Personal Information Protection Act (Principles for Protecting Personal Information). The KCYPS 2018 data are disclosed in the National Youth Policy Institute's Youth and Children Data Archive (2022). Any personally identifiable information of the survey respondents in the data was provided anonymously.

Results

Middle school students' characteristics and changes in smartphone dependency

Table 1 presents general characteristics of middle school students in the KCYPS 2018 data. Among all respondents, 53.4% ($n = 1156$) were boys and 46.6% ($n = 1008$) were girls. In 2018, smartphone dependency scores differed according to gender, parent's education level, and subjective economic status. All the variables showed statistically significant differences in smartphone dependency. The mean smartphone dependency score for each year was 30.55 ± 7.34 in 2018, 31.92 ± 7.02 in 2019, and 32.74 ± 7.39 in 2020.

Trajectory of middle school students' smartphone dependency

Upon analyzing the longitudinal trajectory of middle school students' smartphone dependency from 2018 to 2020, the initial mean intercept was 30.65 ($p < .001$), and the mean slope was 1.09 ($p < .001$), which was statistically significant. As for the model fit, both CFI and TLI were 0.95 or higher, and RMSEA was 0.05 or less; this indicates that the model has a good fit to the data (CFI = 0.996, TLI = 0.989, and RMSEA = 0.04; Table 2).

Latent class according to the trajectory of smartphone dependency of middle school students

Table 3 shows the results of identifying the latent class according to the trajectory of middle school students' smartphone dependency using LCGM. We selected the three-latent-class model as the best model after comparing two- to five-latent-class models based on their model fit index, number of samples, and interpretability. As the number of classes increased, the AIC, BIC, and adjusted BIC for each model tended to decrease, indicating that the five-latent-class model is more favorable. For reasons of power and precision of the multinomial logistic regression analysis, the latent class should be at least 5% of the total sample (Pan et al., 2019); however, there are latent classes of <5% in the four-class and five-class models. Therefore, the three-latent-class model was adopted.

Fig. 1 shows the three latent classes classified according to smartphone dependency trajectories. Class 1 started with a low initial value of smartphone dependency (intercept: 23.01, $p < .001$), and as there was no statistically significant change in the slope (slope = 0.44, $p = .121$), we named it the "low-stable" class. Of all middle school students, 15.3% ($n = 332$) belonged to class 1. In class 2, smartphone dependency started at a moderate level (intercept = 30.37, $p < .001$), and the slope increased slightly (slope = 1.30, $p < .001$); therefore, we named it the "medium-increasing" class. Of all middle school students, 66.3% ($n = 1434$) belonged to class 2. In class 3, the initial value of smartphone dependency was high (intercept = 37.79, $p < .001$), and the slope

Table 1

Sample Characteristics of Middle School Students in the 2018 Korean Children and Youth Panel Survey data (N = 2164).

Variables	Categories	n (%) or M ± SD	Observed range	Smartphone dependency (2018) M ± SD	t/F or r (p) Scheffé
Demographic factors					
Gender	Boy	1156 (53.4)		29.87 ± 7.09	−4.63 (<0.001)
	Girl	1008 (46.6)		31.33 ± 7.54	
Parent's education level (n = 2160)	≤ High school	819 (2.5)		31.09 ± 7.44	2.66 (0.008)
	≥ College	1341 (62.1)		30.22 ± 7.26	
Subjective household economic status (n = 2159)	Good[a]	289 (13.4)		31.62 ± 7.46	5.49 (0.004) a > c
	Fair[b]	1652 (76.5)		30.50 ± 7.36	
	Poor[c]	218 (10.1)		29.49 ± 6.93	
Individual factors					
Aggressive behavior		11.53 ± 3.54	6–24		0.42 (<0.001)
Depressive symptoms		17.99 ± 6.37	10–40		0.39 (<0.001)
Self-esteem		29.97 ± 5.05	11–40		−0.40 (<0.001)
Social withdrawal		10.79 ± 3.75	5–20		0.29 (<0.001)
Parent's factors					
Parent's smartphone dependency (n = 2159)		26.50 ± 6.60	15–54		0.16 (<0.001)
Parenting attitude		71.96 ± 10.17	29–92		−34 (<0.001)
Parent's self-esteem		30.11 ± 3.96	15–40		−0.12 (<0.001)
Relationship factors					
Positive peer relationships		25.01 ± 4.27	8–32		−0.14 (<0.001)
Negative peer relationships		9.24 ± 2.59	5–20		0.29 (<0.001)
Relationship with a teacher		39.25 ± 6.95	14–56		−22 (<0.001)
School satisfaction (n = 2134)		4.07 ± 0.90	1–5		−0.22 (<0.001)
Dependent variable					
Smartphone dependency	2018	30.55 ± 7.34	15–58		
	2019	31.92 ± 7.02	15–58		
	2020	32.74 ± 7.39	15–55		

Table 2

Trajectory of Smartphone Dependency among Middle School Students (N = 2164).

Latent variables	Mean	SE	p	x^2 (p)	CFI	TLI	RMSEA
Initial intercept	30.65	0.15	<0.001	4.41 (0.036)	0.996	0.989	0.04
Slope	1.09	0.09	<0.001				

Note. SE = standard error; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation.

Table 3

Determining the Number of Latent Classes according to Smartphone Dependency Trajectory (N = 2164).

Model	Model fit			n(%) according to latent class				
	AIC	BIC	Adjusted BIC	Class 1	Class 2	Class 3	Class 4	Class 5
2-class model	43,326.27	43,371.71	43,346.29	1374 (63.5)	790 (36.5)			
3-class model	43,055.94	43,118.42	43,083.47	332 (15.3)	1434 (66.3)	398 (18.4)		
4-class model	43,018.81	43,098.32	43,053.84	1243 (57.4)	618 (28.6)	30 (1.4)	273 (12.6)	
5-class model	42,990.78	43,087.33	43,033.32	1184 (54.7)	36 (1.7)	43 (2.0)	259 (12.0)	642 (29.7)

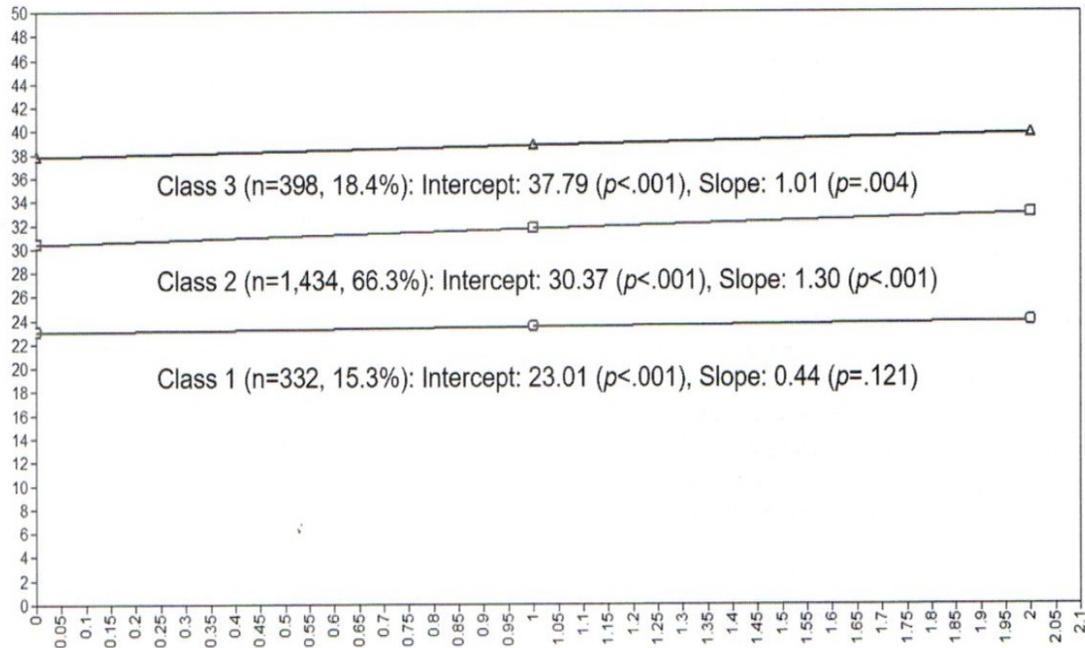*Note.* AIC = Akaike information criterion; BIC=Bayesian information criterion.

Fig. 1. Latent classes of smartphone dependency trajectories.

increased slightly (slope = 1.01, p = .004); we named it the "high-increasing" class. Middle school students belonging to class 3 accounted for 18.4% (n = 398) of the total.

Table 4

Multinomial Logistics Regression.

Variables		Class 1 (Low-stable)		Class 3 (High-increasing)	
		OR	(95% CI)	OR	(95% CI)
Gender (ref. boy)		0.966	(0.741–1.260)	**1.587**	**(1.237–2.036)**
Parent's education level (ref. ≥ college)		0.787	(0.595–1.041)	0.988	(0.770–1.268)
Subjective household Economic status (ref. good)	Poor	0.907	(0.517–1.588)	1.512	(0.881–2.596)
	Fair	0.894	(0.597–1.339)	1.448	(0.920–2.281)
Aggressive behavior		**0.909**	**(0.865–0.956)**	**1.111**	**(1.062–1.163)**
Depressive symptoms		1.009	(0.977–1.041)	1.011	(0.982–1.041)
Self-esteem		**1.083**	**(1.042–1.125)**	0.995	(0.961–1.030)
Social withdrawal		0.993	(0.953–1.035)	1.036	(0.996–1.077)
Parent's smartphone dependency		0.983	(0.962–1.004)	**1.023**	**(1.004–1.042)**
Parenting attitude		1.017	(1.000–1.034)	**0.979**	**(0.965–0.993)**
Parent's self-esteem		1.000	(0.964–1.036)	0.983	(0.951–1.016)
Positive peer relationships		0.993	(0.959–1.029)	1.023	(0.991–1.057)
Negative peer relationships		**0.927**	**(0.872–0.985)**	1.028	(0.974–1.084)
Relationship with a teacher		1.003	(0.982–1.024)	0.993	(0.974–1.013)
School satisfaction		0.984	(0.828–1.169)	0.887	(0.768–1.024)

Note. Reference = Class 2 (Medium-increasing); ref. = reference; OR = odds ratio; CI = confidence interval. Bold figures indicate significant values.

Predictors of each latent class

Table 4 shows results of determining predictors that identify the latent class with different trajectories of middle school students' smartphone dependency using multinomial logistic regression analysis. The reference group was class 2 (medium-increasing). The Durbin-Watson statistic was 1.86, and there was no autocorrelation of residuals. The variance inflation factor was 1.08–2.55 and tolerance was 0.39–0.92; therefore, there was no problem of multicollinearity between independent variables.

Aggressive behavior, self-esteem, gender, negative peer relationships, parent's smartphone dependency, and parenting attitude were statistically significant predictors of latent class membership in the multinomial logistic regression analysis (Table 4). First, the lower the aggressive behavior (odds ratio [OR] = 0.909; confidence interval [CI] = 0.865–0.956), the higher the self-esteem (OR = 1.083, CI = 1.042–1.125), and the lower the negative peer relationships (OR = 0.927, CI = 0.872–0.985), the higher the likelihood of belonging to the low-stable class compared with the reference group. Second, more girls than boys (OR = 1.587, CI = 1.237–2.036) have higher aggressive behavior (OR = 1.111, CI = 1.062–1.163), higher parent's smartphone dependency (OR = 1.023, CI = 1.004–1.042), lower parenting attitude (OR = 0.979, CI = 0.965–0.993), and higher likelihood of belonging to the high-increasing class compared with the reference group.

Discussion

This study identified the trajectory of smartphone dependency over time using data of 2164 middle school students obtained from the KCYPS 2018. We also identified latent classes with different trajectory patterns within the entire group and predictors of each class.

The LGCM result showed that smartphone dependency of Korean middle school students increased over a 3-year period from the first to third grades of middle school (intercept 30.65, slope 1.09). This result is similar to that of a previous study on the smartphone dependency of Korean adolescents. In Cho (2019) study on students from the fourth grade of the elementary school (10 years old) to first grade of middle school (13 years old), and Kim et al. (2021) study on students from the fifth grade of elementary school (11 years old) to second grade of middle school (14 years old), smartphone dependency increased significantly over time. This may be because, as the anxiety and burden of change and adaptation increase when transitioning from elementary to middle school, children's stress increases, and smartphone use increases to relieve it, making it easy to develop dependency (Cho, 2019).

However, Yoon et al. (2020) study of students in the third year of middle school (13 years old) to third year of high school (18 years old) showed a decrease in smartphone dependency. In the annual survey in Korea, the smartphone dependency of middle school students was higher than that of high school students (National Information Society Agency, 2022). This is because high school students are directly involved in entrance examinations; therefore, they spend less time on their smartphones compared to middle school students and have an attitude of controlling their smartphone use (Lee, 2017; National Information Society Agency, 2022). Moreover, middle school students have a higher tendency toward virtual world orientation and reliance on smartphones for social relationships compared with high school students (Kim, 2021). However, as this study used data for only 3 years of middle school students, changes afterward could not be confirmed. Further studies using extensive long-term data are required in the future.

Although the smartphone dependency of all Korean middle school students increased, LCGM classified the students into three latent classes with differential trajectories: (1) the medium-increasing group with the median initial value and largest increase in the slope (66.3%), (2) the high-increasing group with a high initial level and increase in the slope (18.4%), and (3) the low-stable group with a low initial value and no significant change (15.3%). Ha (2014) divided the adolescents aged 13–16 years into three subgroups of smartphone dependency trajectory: middle-level group (43.4%), low-level increasing group (45.4%), and high-level decreasing group (11.2%). Moreover, Seo and Choi (2018) divided adolescents aged 10–14 years into three subtypes of smartphone dependency trajectory: low dependency-increasing group (70.6%), middle dependency-stability group (26.1%), and high dependency-decreasing group (3.3%). Lee and Yeum (2018) divided adolescents aged 11–15 years into two groups: increasing group (91.6%) and decreasing group (8.4%).

In previous studies, smartphone dependency in the high-risk group decreased over time and that in the low-risk group increased. Therefore, at the final time point, both their values were similar to that of the middle group, leading to ambiguity in the meaning of the subgroup classification. However, in this study, the trajectories were clearly distinguished from each other at the start and end points. Specifically, the trajectories classified in this study were as follows: a group that started with a low state and maintained its trajectory, moderate state and further increased its trajectory, and high state and further increased its trajectory. This means that the target population was divided according to the degree of risk.

Furthermore, the findings of this study emphasize the need for an intervention for smartphone dependency. Although a direct comparison is not possible due to the different age groups included in each study, in this study, the proportion of the latent class with relatively low smartphone dependency decreased, and that of the intermediate- and high-risk groups increased compared to previous studies. This suggests that management of medium and high initial groups has become more important than before. In particular, smartphone dependency in the high initial groups tended to decrease in previous studies (Ha, 2014; Lee & Yeum, 2018; Seo & Choi, 2018); however, in this study, smartphone dependency increased in high initial groups. That is, smartphone

dependency decreased over time without any special intervention in the high initial group in the previous studies, but smartphone dependency of the high initial group increased in the natural state in our study. Various environmental factors such as changes in individual-centered online life and increase in working parents—along with the media characteristics of smartphones, which have become much more diverse and interesting due to the rapid growth of information technology compared to 10 years ago—further increased the smartphone dependency of Korean middle school students. This result can be interpreted in the same context wherein the smartphone usage rate of middle school students is increasing every year (National Information Society Agency, 2022).

In this study, the initial values of predictors that determine the class were explored to understand the characteristics of each class. Result of the multinomial logistic regression showed that samples that included more girls than boys, higher aggression, higher parent's smartphone dependency, and more negative parenting attitudes were more likely to belong to the high-increasing group with high smartphone dependency compared to the medium-increasing group. However, the lower the aggressiveness, the higher the self-esteem and the lower the negative peer relationships, the more likely they were to belong to the low stable group with less smartphone dependency compared with the medium-increasing group.

First, aggression was the most significant predictor in classifying the latent class in this study. Aggression is reported to begin in childhood, increase until mid-adolescence, and then gradually decline, culminating at about 11–14 years of age; aggression expressed in early adolescence predicts severe aggression in adulthood and problematic behaviors such as addiction and violence (Kim, 2019). Aggression is not only a cause and consequence of smartphone dependency (Kim, 2018) but also directly effects smartphone dependency (Kim & Lee, 2018). This is likely because, instead of expressing aggression in the real world, adolescents with high aggression express it in the virtual world through smartphones. For example, they play violent smartphone games, post malicious comments on social network services, and steal personal information (Park & Park, 2020). In addition, some content, such as highly violent smartphone games, may increase aggression by easy accessibility to violent games regardless of the location (Park, 2019). In particular, in a meta-analysis study on the factors influencing smartphone dependency (Lee, 2017; Lee & Kang, 2015), aggression was an important predictor compared to other individual factors. Aggression (effect size [ES] = 0.388 in Lee & Kang, 2015; ES = 0.458 in Lee, 2017) had a greater effect than depression (ES = 0.155 in Lee & Kang, 2015; ES = 0.377 in Lee, 2017) and social withdrawal (ES = 0.200 in Lee, 2017).

In the high-increasing group, besides aggression, parental factors such as parent's smartphone dependency and parenting attitude, as well as gender, were significant predictors of latent class distinction. Middle school students and their primary caregivers are interdependent, and parent's smartphone dependency hinders the development of their children, causes various psychological problems, and directly affects children's smartphone dependency (Ha, 2020). When parents use smartphones, they are unable to react sensitively in communication with their children due to the distractions of smartphone use; this makes it difficult to promote high-quality parent-child interaction and social bonding, resulting in a negative parenting attitude (Ha, 2020; Kildare & Middlemiss, 2017; Kushlev & Dunn, 2019). Furthermore, the fact that the high-increasing group had more girls than the medium-increasing group was consistent with previous research showing that girls are more vulnerable to smartphone dependency than boys (Cho, 2019; Ha, 2020; Lee & Kim, 2020; Son et al., 2021). It is known that the relational and emotional characteristics of smartphones are more in line with girls than boys. Girls tend to rely on smartphones for emotional problems such as anxiety and depression (Kim, 2021). Moreover, girls are more affected by their parents' negative parenting attitudes than boys, and girls' relationships with their parents have a significant impact on their smartphone dependency, compared to boys (Choi, 2020; Ko & Ha,

2020). Therefore, it is necessary to consider a tailored intervention for girls who are sensitive to relational characteristics and actively empathize with their psychological difficulties, and to involve parents when structuring high-risk intervention programs. For example, drama therapy or cognitive behavioral therapy, which are effective for depression in female adolescents, can be applied to intervention programs (Feiss et al., 2019; Lee, 2018).

Although the increased smartphone dependency of many middle school students increased, the low-stable group remained low on smartphone dependency for the 3-year study period. Middle school students in this group had higher self-esteem and lower negative peer relationships than adolescents in the medium-increasing group. Prior research has shown that adolescents assess themselves more positively when they feel a sense of belonging and closeness among their peers, and do so negatively when they feel isolated or marginalized. Love, help, friendship, and support from friends are good resources for self-esteem formation, and the more friends adolescents can rely on in times of difficulty, the higher their self-esteem; however, negative experiences such as bullying or isolation in their friendships will make them feel depressed, anxious, and inferior (Ko, 2019). In addition, the sense of security that middle school students feel in peer relationships is important, as it influences emotions such as self-esteem and aggression, which affect smartphone dependency (Choi, 2020). Moreover, students in the low-stable group may have social skills to resolve conflicts with their peers well. The security they feel in peer relationships based on social skills is linked to the development of self-esteem that values them. Accordingly, they become relatively less dependent on smartphones. In other words, to prevent middle school students from relying on smartphones, social skills training and counseling programs that allow them to discover their strengths and resources will be helpful so that they can evaluate themselves more positively.

Limitations

This study has some limitations. First, it used only 3-year data of students in the first year (13 years old) to third year (15 years old) of middle school, which is known to be the most serious period of smartphone dependency. Given that many psycho-emotional problems can occur during this transitional period in which students move from their previous environment to a new environment after middle school, future research needs to explore long-term longitudinal changes by considering high school data.

Second, this study did not reflect the time-varying characteristics as it input only the initial values of predictors. The middle school years are a period of rapid development, and there is a possibility of changes in individual and relational factors. In future studies, it is necessary to confirm the effect of changes in predictors over time on the trajectory.

Third, as this study used panel data, there were limitations in the variables that could be used. For example, parenting attitude is a variable related to the parent, but the KCYPS data are included in only the child/adolescent questionnaire. Therefore, the parenting attitude variables included in this study reflect only the child's perception. As there are no variables to measure parenting attitudes in the KCYPS caregiver questionnaire, we suggest to include measurable items to measure parenting attitudes as perceived by parents. This is because parenting attitude requires considering not only what the child perceives but also multiple informants about how parents raise their children.

Finally, as this study is conducted with Korean adolescent data, it is necessary to be careful about generalization. Korean adolescents have the highest smartphone usage rate in the world. Moreover, they are characterized by long study hours and lack of leisure activities compared to adolescents in other countries (Lee & Song, 2021; Song et al., 2021). Therefore, we suggest to conduct repeated studies in other countries and cultures and compare their results with those for Korean adolescents' smartphone dependency latent classes.

Implications to practice

The study results provided clues regarding which factors to focus on—such as schools and institutions—for each subgroup with different levels of smartphone dependency when developing an intervention program for middle school students in the community. For example, aggression was a significant factor differentiating the three latent classes. This suggests that appropriate education, counseling, and therapeutic counseling to control aggression are essential for intervention programs related to smartphone dependency for middle school students. Compared to the medium-increasing group, the high-increasing group should focus on interventions for girls and their parents. As there are relatively more girls in the high-risk latent class, it is necessary to design intervention programs that consider the emotional characteristics of adolescent girls. To help parents understand the characteristics of the young generation and the smart media environment, educating parents about the changing communication culture and lifestyle should be included in the parenting program, and active participation should be promoted. Most current interventions are aimed only at adolescents, and there are not enough programs for parents and children to participate together compared with adolescents' programs by age group. In a meta-analysis of psychological interventions for the Internet or smartphone addiction in adolescents, only one of six studies included in the final analysis involved parental training as an intervention (Malinauskas & Malinauskiene, 2019). For example, there was a good case in which parental counseling was included in a camp-type intervention program targeting female adolescents with high-level smartphone addiction (Kim et al., 2016). There is also a need to include parents in intervention programs that target a wider range of adolescents, not just high-risk groups. Moreover, it is important to manage the medium-increasing group, as its slope is higher than that of the high-increasing group. Programs for this group will need strategies to develop self-esteem and social skills. For prevention of smartphone dependency, community nurses, such as school nurses and mental health nurses, can not only screen the high-risk group but also play a role as professional counselors who can provide high-quality counseling. Such counseling can inform adolescents about the dangers of smartphone dependence and help them to use smartphones correctly.

Conclusions

This study contributed to identifying the change pattern of smartphone dependency for Korean middle school students over time. In addition, it differentiated subgroups that could be distinguished according to the trajectory of smartphone dependency among all adolescents. This study makes a significant contribution, as it identified the high-risk group of smartphone dependency through a longitudinal analysis using national data. Moreover, it not only indicated the highest risk group but also identified the need for intervention in the middle group, which includes most participants (approximately two-thirds) with increased smartphone dependency. In addition, the significant predictors for each latent class were different in this study. The findings can thus be used in the development of nursing interventions for smartphone dependency in adolescents.

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CRediT authorship contribution statement

Eunjoo Kim: Conceptualization, Investigation, Writing – original draft, Methodology, Data curation, Visualization, Software, Validation, Supervision. **Juhyun Jo:** Conceptualization, Investigation, Writing – original draft. **Min Kyung Song:** Conceptualization, Investigation,

Writing – original draft.

Declaration of Competing Interest

None. The authors declared no conflict of interest.

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